

REMARKS

Reconsideration of the present application is respectfully requested.

Applicant notes with appreciation the acknowledgement of the claim for priority under 35 U.S.C. §119(b) and the notice that all of the certified copies of the priority documents have been received.

Applicant appreciates receiving a copy of form PTO-1449, on which the Examiner has initialed each listed reference.

Applicant has amended the specification to correct minor typographical and translation errors. Applicant respectfully asserts that no new matter has been added.

In addition, Applicant has amended certain of the pending claims to more clearly recite the physical quantity detection device of the present invention. Specifically, claim 2 has been amended to correct a minor clerical error and claim 6 has been amended to depend from claim 1 since claim 5, from which claim 6 previously depended, has been incorporated into claim 1 and claim 5 has accordingly been canceled.

Claims 1 and 3 have been objected to due to informalities. Specifically, the Examiner has objected to the term “temperature coefficient of resistor” in claim 1. Applicant has amended the claim to correctly recite a “temperature coefficient of resistance” per the Examiner’s instructions. In addition, the Examiner has objected to the unit of impurity concentration as recited in lines 3 and 5 of claim 3. Applicant refers the Examiner’s attention to Appendix A, wherein impurity concentration is referred to in units of m^{-3} . Since scaling between units of m^{-3} and cm^{-3} is a trivial calculation, Applicant respectfully asserts that cm^{-3} is a valid unit and respectfully requests that the Examiner’s objection to claim 3 be withdrawn.

Claim 1 has been rejected under 35 U.S.C. §112. Specifically, claim 1 has been rejected for having insufficient antecedent basis for the limitation “said second temperature coefficient.” Applicant respectfully asserts that the above-discussed amendment to claim 1, namely, the amendment of the term “temperature coefficient of resistor” to “temperature coefficient of resistance” has inherently provided sufficient antecedent basis. Applicant therefore respectfully requests that the rejection under 35 U.S.C. §112 of claim 1 be withdrawn.

Claims 1-5, 8, 11-12 and 14-18 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,233,848 to Sato et al. (Sato) in view of U.S. Patent No. 4,576,052 to Sugiyama. Claim 5 has been canceled. Therefore, Applicant will not discuss this rejection in connection with claim 5. Applicant respectfully traverses this rejection with respect to claims 1-4, 8, 11-12 and 14-18.

The physical quantity detection device of the present invention includes an operational amplifier OP1 and first and second resistors Ra and Rb that are connected in series between two reference potentials Vcc and ground. A feedback resistor Rts is located between the inverting input and the output of the operation amplifier OP1. The inverting input of the operational amplifier OP1 is also connected to the junction between the first and second resistors Ra, Rb. The temperature coefficients of resistance TCR of the first and second resistors Ra, Rb are the same, and the difference between the TCR of the first and second resistors Ra, Rb and the temperature coefficient of sensitivity TCS of the first and second resistors Ra, Rb is approximately equal to the temperature coefficient of resistance TCR of the feedback resistor Rts, also known as TCRts. A third resistor R1 and a fourth resistor R2, which are also connected in series between the reference potentials Vcc and ground, generate a reference voltage Vref that is supplied to the non-inverting input of the operational amplifier OP1. The temperature coefficient

of resistance TCR of the third resistor R1 and the fourth resistor R2 are approximately equal so that the reference voltage Vref can be kept constant despite variations in temperature (see FIG 1 and page 16, lines 1-11).

Specifically, claim 1 currently recites, *inter alia*:

a first resistor...;
a second resistor connected between said inverting input of said operational amplifier and a second reference potential, ***said first and second resistors having a first temperature coefficient of resistance;***
a feedback resistor ... having a second temperature coefficient of resistance; and
a reference voltage generation circuit generating a reference voltage supplied to a non-inverting input of said operational amplifier, at least one of said first and second resistors comprising a sensing element of which resistance varies on the basis of a physical quantity with a temperature coefficient of sensitivity, ***wherein a difference between said first temperature coefficient of resistance and said temperature coefficient of sensitivity is substantially equal to said second temperature coefficient of resistance, and wherein said reference voltage generation circuit includes third and fourth resistors connected in series between said first and second reference potentials to generate a divided voltage as said reference voltage, and wherein a temperature coefficient of resistance of said third resistor is substantially equal to a temperature coefficient of resistance of said fourth resistor so that said reference voltage can be kept constant irrespective of temperature variation.*** [emphasis added]

Sato discloses a strain gauge pressure transducer capable of temperature change compensation (see col. 2, lines 1-5) including a resistor 4 connected between an inverting input of an operational amplifier 6 and a node (first reference potential) a. Sato also discloses a resistor 31 connected between the inverting input node d of the operational amplifier 6 and a node (second reference potential) k, a circuit including a voltage source Vcc, resistors 29 and 30, and a circuit (Vcc, resistor 29, node k, resistor 30) that generates a voltage that is supplied to a non-inverting input of the operational amplifier 6. However, Sato fails to disclose a feedback resistor or that the resistors 4 and 6 (first and second resistors) have a common coefficient of resistance. Further, Sato fails to teach or suggest a relationship between the temperature

coefficient of resistance for the first and second resistors and a temperature coefficient of sensitivity with respect to a temperature coefficient of resistance for the feedback resistor.

In addition, the first and second reference potentials as recited in claim 1 differ from the first and second reference potentials the Examiner alleges are disclosed by Sato. Specifically, Sato discloses a third resistor 29 and a fourth resistor 30 connected between Vcc and ground. However, the third and fourth resistors 29, 30 are not connected between the first and second reference potentials as are the third and fourth resistors of claim 1. More specifically, as discussed above, the Examiner has stated on page 3, lines 10-11 of the Office Action that node a represents a first referential potential and node k represents a second referential potential. Following the Examiner's logic, resistors 29 and 30 would have to be connected in series between node a and node k to teach or suggest the third and fourth resistors of claim 1.

Sugiyama discloses a temperature independent semiconductor transducer with a strain sensitive region including strain gages 21-24, an operational amplifier 5, and a parallel-connected resistor 81 (feedback resistor) that is integrally formed on a silicon substrate 1. Sugiyama also discloses that the difference between a temperature coefficient of resistance and the temperature coefficient of sensitivity of each of the strain gages 21-24 becomes substantially the same as the temperature coefficient of resistance of the parallel-connected resistor 81 (see col. 6, lines 43-52).

However, Sugiyama fails to teach or suggest that the reference voltage can be kept constant irrespective of temperature variation. Specifically, the strain gages 23 and 24 (third and fourth resistors) generate a reference voltage that varies in accordance with temperature change.

Thus, Sugiyama does not teach or suggest the third and fourth resistors of the reference voltage generator that provide a constant reference voltage irrespective of temperature as recited in claim 1.

Therefore, Sato and Sugiyama, considered individually or in combination, fail to teach or suggest all of the features of the physical quantity detection device of claim 1. For example, neither Sato nor Sugiyama teaches or suggests a reference voltage generation circuit that includes third and fourth resistors connected in series between first and second reference potentials to generate a divided voltage as a reference voltage, and wherein a temperature coefficient of resistance of the third resistor is substantially equal to a temperature coefficient of resistance of the fourth resistor so that the reference voltage can be kept constant irrespective of temperature variation. In view of the above arguments, Applicant respectfully requests that the rejection under 35 U.S.C. §103(a) of claim 1, as well as its dependent claims 2-4, 8, 11-12, 14 and 17-18, be withdrawn.

Independent claim 15 also recites a physical quantity detection device including a reference voltage generation circuit having a third and fourth resistor connected in series between first and second reference potentials. Claim 15 further recites that the temperature coefficients of resistance of the third and fourth resistors are substantially equal. As discussed above in connection with claim 1, neither Sato nor Sugiyama teaches or suggests a physical quantity detection device including this feature. Therefore, Applicant respectfully requests that the rejection under 35 U.S.C. §103(a) of claim 15 be withdrawn.

Independent claim 16 recites a physical quantity detection device a reference voltage generation circuit that generates a reference voltage that is supplied to a non-inverting input of an operational amplifier. This feature is not taught or suggested by Sato or Sugiyama. Specifically, Sato discloses that the reference voltage generation circuit generates a reference voltage that is supplied to a non-inverting input of an operational amplifier through a resistor 31 and a switch 33. Sugiyama discloses that the signal at the junction point 12 is divided by a resistor R_f 82 and then

supplied to the non-inverting input of the amplifier 5. Therefore, since neither Sato nor Sugiyama teach or suggest all features of Applicant's claim 16, Applicant respectfully requests that the rejection under 35 U.S.C. §103(a) of claim 16 be withdrawn.

Claims 6-7 and 9-10 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Sato in view of Sugiyama and further in view of U.S. Patent No. 5,042,307 to Kato. Applicant respectfully traverses this rejection.

Kato discloses a pressure sensor circuit including adjustable (trimming) resistors 22-26 provided for zero point adjustment. However, Kato fails to overcome the shortcomings of the combination of Sato and Sugiyama with respect to independent claim 1 as discussed above. That is, Kato fails to teach or suggest a reference voltage generation circuit that includes third and fourth resistors connected in series between first and second reference potentials to generate a divided voltage as a reference voltage, wherein a temperature coefficient of resistance of the third resistor is substantially equal to a temperature coefficient of resistance of the fourth resistor so that the reference voltage can be kept constant irrespective of temperature variation.

Since the combination of Sato, Sugiyama and Kato fails to teach or suggest all features of independent claim 1, from which claims 6-7 and 9-10 depend, Applicant respectfully requests that the rejection under 35 U.S.C. §103(a) of claims 6-7 and 9-10 be withdrawn.

Claim 13 has been objected to as being dependent upon a rejected base claim. The Examiner indicated that claim 13 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicant notes with appreciation this indication of allowability, and in response has amended claim 13 to be in independent form and to include all of the limitations of claim 1. Claim 13 is therefore in condition for allowance.

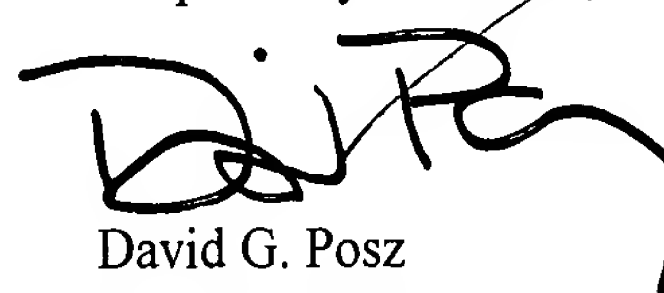
New claims 19-21 are presented. New claims 19-21 recite the physical quantity detection device in a manner that is supported by the specification and drawings. New independent claim 19 generally corresponds to claims 15 and 16 and further recites that the reference voltage generation circuit is connected between the first and second reference potentials. New claim 19 also recites that a difference between the first temperature coefficient of resistance and the temperature coefficient of sensitivity is substantially equal to the second temperature coefficient of resistance and that the reference voltage is directly supplied to a non-inverting input of an operational amplifier. As discussed above in connection with claim 16, this feature is not taught or suggested by the cited art. New claims 20 and 21 depend from claim 19 directly and indirectly, respectively, and recite further details of the reference voltage generation circuit.

A petition for a two-month extension of time along with a check for the requisite petition fee is being submitted concurrently with the present amendment. Although no additional fees are believed to be due, permission is given to charge any additional unforeseen fees to Deposit Account 50-1147.

In view of the above amendments and remarks, the present application is now believed to be in condition for allowance. A prompt notice to that effect is respectfully requested.

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Respectfully submitted,



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APPENDIX A: McGraw Hill ELECTRONICS ENGINEER'S HANDBOOK, 3rd EDITION

Semiconductor Materials 8-87

mobility due to lattice scattering μ_L is proportional to $T^{-3/2}$. The total mobility μ is related to the individual components as

$$1/\mu = 1/\mu_i + 1/\mu_L \quad (6-73)$$

The mobility of electrons and holes in Si, Ge, and GaAs is shown as a function of impurity concentration in Fig. 6-41. The resistivity of these semiconductors as a function of impurity concentration is shown in Fig. 6-42.

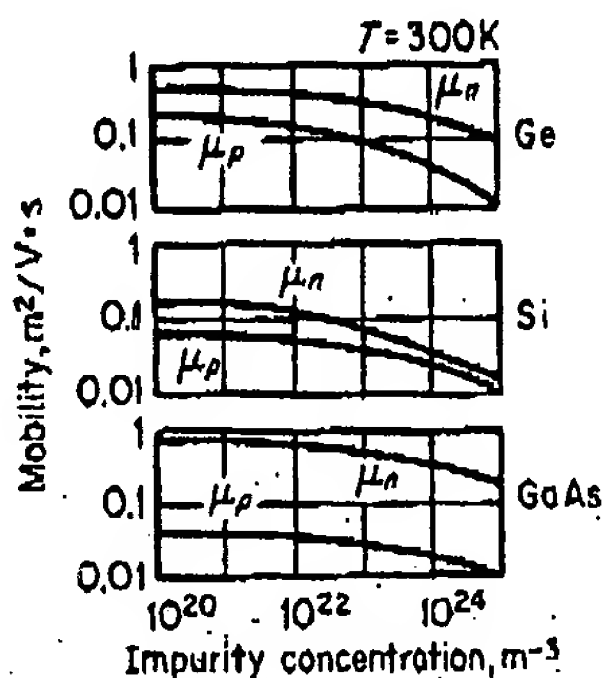


Fig. 6-41. Drift mobility of Ge and Si and Hall mobility of GaAs vs. impurity concentration at 300 K.⁷⁴

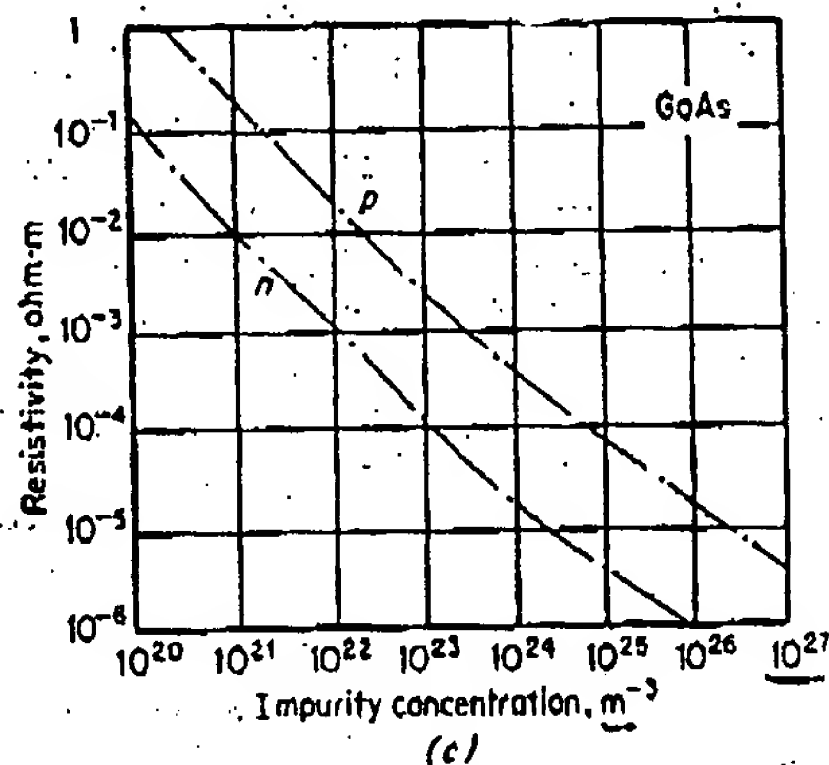
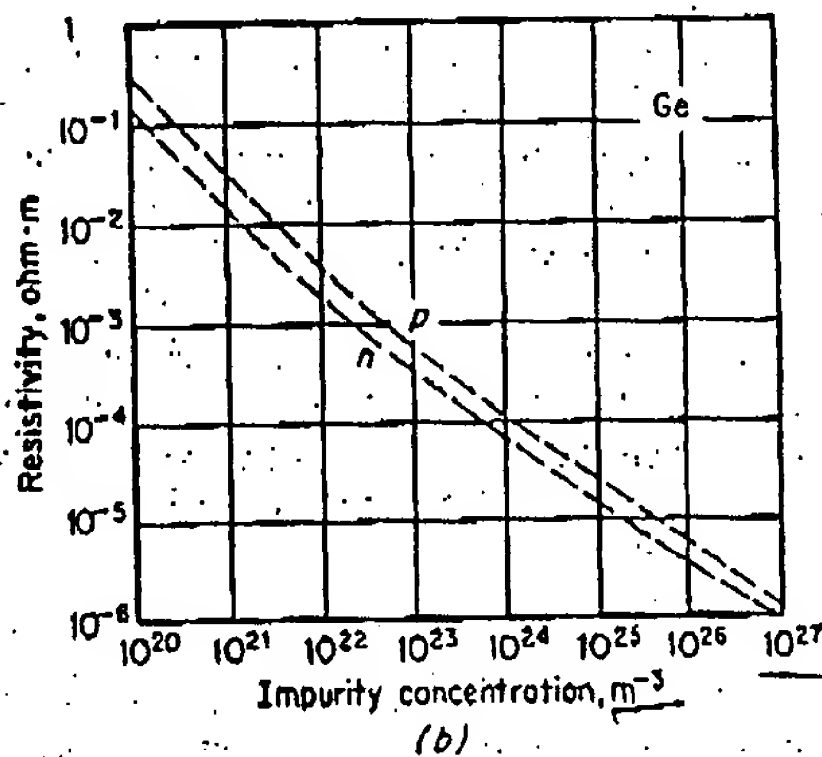
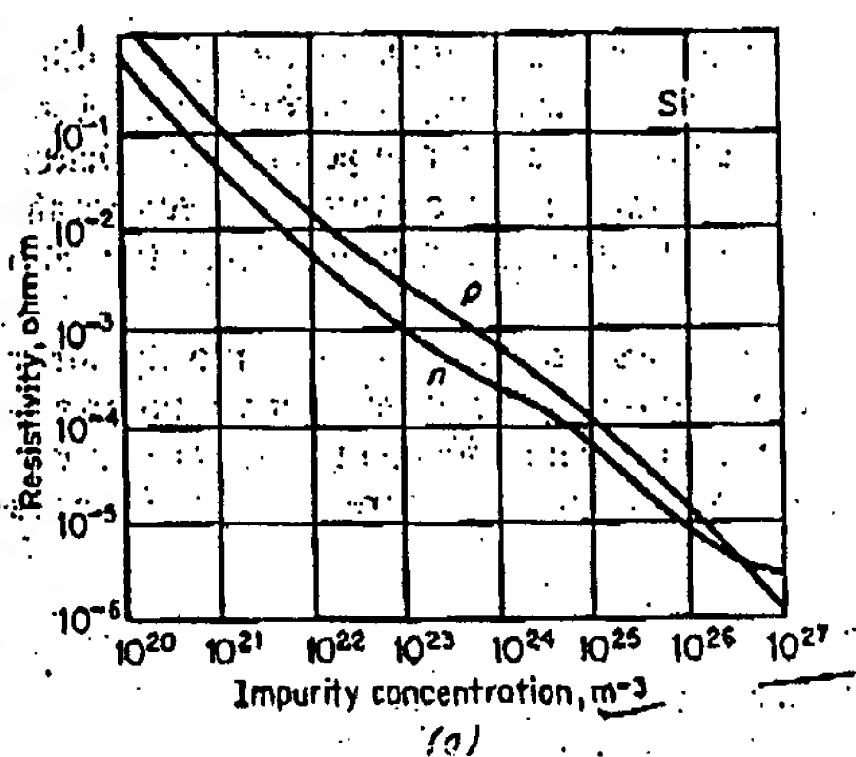


Fig. 6-42. Resistivity vs. carrier concentration at room temperature for (a) Si, (b) Ge, and (c) GaAs.⁹¹⁻⁹³